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eco@work

Sustainable reading from the Oeko-Institut

The space below ground

How to use it properly?

Regional development
Interview with Helmuth von Nicolai

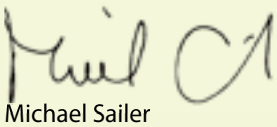
Grappling with the underground environment

Have you been to Hallstatt in Upper Austria? I last visited the oldest saltmine in the world only two years ago and found it fascinating, even though I'd been before. There is evidence that people have mined salt here ever since the Bronze Age – that is, since around 1500 BC. Today, when one sees these sets of steps, hewn by hand, that were dug up to 100 metres deep into the Hallstatt Salzberg, one cannot help but feel a certain reverence for miners. Mankind has long lived from and with the underground environment – salt, coal, minerals and groundwater are just some of the resources that we take from it. In Germany in particular there is a centuries-old tradition of mining in many regions, which has brought widespread prosperity.

Nevertheless, we can see too that careless management of what lies below ground can lead to problems. In Germany we have seen mining damage that erupts to the surface and land that will not be usable in the long term, for example where uranium has been extracted. Improper storage of chemicals and radioactive substances could lead to large-scale underground contamination, from which the risks to our groundwater would only be the start. At the Oeko-Institut we are convinced that we need a regulatory policy for the underground environment which strikes a balance between the opportunities, risks and challenges involved in extractive activities and responsible resource policy. In our view this should not be based on the interests of individual players, but should be guided by a comprehensive, strategic plan of action.

In this issue of eco@work we describe these challenges, report on what we have learnt from projects concerned with the underground environment and, last but not least, explore sustainable resource policy. Whereas the resources in Hallstatt, for example, used to be used sparingly, not least because of the difficulty of mining salt by hand, nowadays we can see many instances in other places of resource extraction and use that have to be regarded as unsustainable. This issue makes a case for more care underground and illustrates how to organise a responsible management of the space beneath our feet.

I hope you had a Happy New Year and that 2014 has started well for you.



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"Thousands of core samples provide us with information about the subterranean environment"

Regional planning law compels the German federal states (Länder) to produce state-wide regional plans at regular intervals. This regional development programme is currently in production in Mecklenburg-Western Pomerania. It is to be completed by 2015 and contains an important innovation: for the first time consideration will also be given to subterranean spatial planning. Helmuth von Nicolai leads the department of legal matters and mining at the Ministry of Energy, Infrastructure and Regional Development of Mecklenburg-Western Pomerania. Here he tells eco@work about the approach towards underground spatial planning and the challenges in implementing it.

Mr von Nicolai, why did Mecklenburg-Western Pomerania decide to include subterranean spatial planning in the regional development programme?
There is a growing number of potential conflicts of use underground. Whether it's drinking water extraction, the use of geothermal energy or oil production, more and more uses are competing for what is beneath the surface. The 2012 law on carbon storage underground has added another potential use likely to generate particular conflict. Mecklenburg-Western Pomerania now has to look at whether there are suitable CO_2 repositories and also whether there are other uses of underground space that will conflict with these. To find that out, we need subterranean spatial planning. That is the only way we can resolve the potential conflicts of use satisfactorily.

What do you think are the particular challenges of spatial planning below ground?
The main challenge is of course that we know considerably less about what is below ground than what is above it. A lot more data needs to be collected. However, I'm optimistic that we can gradually expand our knowledge because, if you compare it with the marine spatial planning that was necessary for offshore wind farms, you can see that we knew very little about the seabed either at the outset, but we now have a lot of reliable data.

Which data sources do you use for subterranean spatial planning?
In Mecklenburg-Western Pomerania one important information base is a very extensive collection of core samples. Thousands of core samples, 70,000 metres of core from approximately 350 drillings, which are stored here, provide us with information about the subterranean environment. They come partly from oil boreholes sunk during the time of the former East Germany. Geophysics offers us further possibilities, for example by seismic techniques. These can give us information about what things might look like below ground.

Is the existing data adequate, then?
It could be more comprehensive, of course. A problem we have in this respect is that much of the geodata in Germany is not accessible to everyone. It remains the property of the person who collected it. In other countries such as Switzerland all geodata is publicly available after one to two years, and even in the Netherlands, which lags behind, it is available after five years.

Do you use above-ground spatial planning instruments as well?
Yes. These have been shown to be useful underground. Although there are of course areas where new approaches need to be developed. For example, two-dimensional drawings are inadequate for showing what is under the ground; we need 3D models as well. However, these can't be incorporated into legally binding documents. That is why we will probably have to use both: two-dimensional layer models of the underground regions in map format for legal validity, and 3D models as well for a better overview.

Thank you for talking to eco@work.
Interview by Christiane Weihe.

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Talking to eco@work: Helmuth von Nicolai, head of the department of legal matters and mining at the Ministry of Energy, Infrastructure and Regional Development of Mecklenburg-Western Pomerania.

To the left, straight after the storage facility

Subterranean spatial planning

When Jules Verne sent his heroes on the journey to the centre of the Earth the subterranean realm was still a world full of mystery. Since then things have changed somewhat: the depths are no longer the setting for adventurous journeys, but instead are used to supply water, extract minerals and store natural gas. Now – partly in the wake of energy system transformation (the Energiewende) – new projects such as storage facilities for electrical energy are being added to these established uses. Despite the potential for using underground space in separate tiers, conflicts between different projects have become inevitable. That is why stringent subterranean spatial planning is essential. It is a question of guaranteeing safe use as much as protecting ecological systems.

In Germany resources have been extracted both above and below ground for many centuries. Today these include coal and lignite, salts and ores, and also stone and soils such as gravel and sand. Groundwater and thermal water are also obtained from below ground. Other existing uses of subterranean spaces include the storage of natural gas and crude oil as well as underground repositories for hazardous wastes. Now new possibilities have emerged as well. "These include geothermal energy", says the Oeko-Institut's Falk Schulze. "While the first geothermal supply system came on stream in Germany around thirty years ago and near-surface systems have become common practice, deep geothermal systems for energy generation have now come onto the market too". However, what are completely new are underground pumped-storage power plants – the first of its kind in the world could be constructed in the Harz in the coming years. "But innovative subterranean compressed air and hydrogen storage facilities are also new possibilities for using underground space", declares Schulze, who is Deputy Head of Environmental Law and Governance. There is particular controversy over two further types of use: fracking, i.e. the use of chemicals in shattering rock structures to release natural gas bound up in the rock, and carbon capture and storage (CCS). "What future CCS and

fracking can have in Germany remains to be seen", says Schulze, "as there is considerable opposition to both processes, not only among the general public, but also at political level."

Underground competition

Claims on the use of underground space will grow, not least with the further development of technologies for interim storage of renewable energy. "In many regions the underground space lends itself to different projects – conflicts of use are bound to occur in these cases", explains Falk Schulze. "That applies to the North German Plain with its saline aquifers and salt formations, which provide favourable conditions for storing natural gas and CO_2 as well as energy."

But how should one deal with this sort of conflict? Which projects should be given priority? And how do you take into account the ones which will only be ready to come onto the market in a few years' time? "In Germany spatial planning is principally a matter for the federal states", the Oeko-Institut scientist says. "Licences for individual projects are issued by the relevant state authorities in each case, albeit taking into account the regional planning regulations, but with regard to the area below ground it is done very much on a case-by-case basis and, where drilling is concerned, absolutely according to the 'first come, first served' principle." He goes on to say that, instead of this, a systematic planning policy should be pursued, looking at how to coordinate all potential underground uses from the outset. The licensing procedures must then be geared to this as well. Individual federal states are already in the process of enshrining these approaches in their state-wide regional development programmes, says Schulze.

Spatial planning at depth

As part of a project for the German Federal Environment Agency the Oeko-Institut is working intensively on subterranean spatial planning. Together with the G.E.O.S. engineering consultancy in Freiberg and the Dresden-based Leibniz Institute of Ecological Urban and Regional Development (IOER), the researchers have analysed what geological information is available for underground spatial planning and which instruments and regulations would be suitable for overcoming the anticipated conflicts of use. "In addition we have developed proposals for adapting the existing planning process, put forward specific suggestions for legal formulas and flagged up the need for further research with regard to a national spatial planning policy extending beyond the responsibilities of the federal states", explains Falk Schulze.

In the geoscientific part of the research project the G.E.O.S. experts first assigned the appropriate geological structures to different uses – i.e. storage, disposal, extraction or underground construction. In addition they analysed the various conflicts of use; these can arise within one geological structure, but also with projects on the surface. The experts also established that more precise data must be obtained about what is below ground. What makes this more difficult is that much of the existing information is gathered by private operators and is

not generally available, being subject to property rights. There should be legislation to change this, thinks Falk Schulze, so that the existing data is made generally available more quickly, as in other countries. This, he says, is in the interests of better and more transparent planning. "However," the scientist adds, "you don't need a database that gives access to every last detail of the information to coordinate different claims on the use of underground space. The key thing is that the available data allows a decision on the spatial distribution of different uses to be weighed up properly at spatial planning level. The data only needs to be more detailed at the licensing stage, that is to say when specific projects are authorised."

In the research into the spatial planning and legal aspects the Oeko-Institut and the IOER concluded that subterranean spatial planning represents a new type of planning challenge on a scale reminiscent of the learning processes related to marine spatial planning – this became part of planning procedures around ten years ago in relation to the designation of offshore wind farms. "In the course of the study it became apparent that in principle the existing set of planning instruments can suffice to deal with competing uses underground as well", explains Schulze. "For example, the impact mechanisms of zoning can be applied as an early management element for underground spaces too". The scientist considers cooperation between the federal states to be vital for tackling the demands of underground spatial planning. "Existing state working groups and conferences of ministers could be used for this, and in addition, as a precautionary measure, certain areas can be secured for specific uses – to protect drinking water, say, or for geothermal energy."

Schulze believes that on the whole the existing legislative basis is suitable for dealing with potential competition between underground uses. "The main thing here is the regional planning law at national and state level, which must, however, be adapted", he explains. "Above all, clarifying provisions need to be adopted which afford more weight to spatial planning below ground." He feels that greater integration between regional planning law and central regulations governing the authorisation of underground projects is also important, especially in mining law, as well as statutory regulation on the options for using the underground environment in separate tiers or layers. One special task for the project's legal team was to examine the possibilities allowed by law for national spatial planning with regard to a federal storage plan for energy storage facilities and to present the options.

Uncharted territory

Projects such as this show that sustainable use of underground space is impossible without strategic and precautionary management. This must take into account both the various options for use and the ecological exigencies. In addition, there must be further and thorough exploration of the subterranean landscape because, despite the uses already established and a raft of new ones, a hundred and fifty years after Jules Verne much of the world beneath us is still uncharted territory.

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Risks for generations

Greater prudence in the depths of the Earth

Sometimes we feel the vibrations from a tube train, or we drive into an underground car park. But what do we really know about the world beneath the surface – and the dangers that can arise from subterranean projects? Some of them, such as the abandoned Stocamine underground waste repository in Alsace, where waste containing amongst other things mercury and arsenic was deposited, still pose a risk for humans and the environment today. This example of waste management shows that one thing is especially necessary in using, and planning the use of, underground spaces, and that is prudence.

When no further resources are extracted from mines, the question often arises of what to do with the spaces that have been created underground. Many are abandoned, but some are put to further use. "Often old mines are turned into repositories for hazardous waste", says the Oeko-Institut's Stefan Alt. This is because it is now the most practical and safest possible option for isolating highly toxic wastes from the natural world when these can no longer be managed in any other way. However, not all old mines provide the right conditions for this. "Depleted coalmines are not suitable as waste repositories for toxic substances and are no longer allowed to be used as such", explains the geologist. "There is too great a risk that the harmful substances could make their way back into the biosphere with the groundwater that enters the mine." The situation is different in some former saltmines: owing to the geological conditions they are generally better protected from flooding – if the conditions are right. "As far as safety is concerned, for example, the former saltmine at Herfa-Neurode provides satisfactory conditions for the underground waste repository now operating there."

Yet even in salt rock not every cavity is necessarily suitable for storing hazardous substances. This can be seen in the example of the Stocamine underground waste repository at Wittelsheim in Alsace. "In 2002, only three years after opening, operations had to be halted following a fire. The subsequent investigation revealed that the cavities in the repository were unstable, although thirty years' stability was a precondition of the planning permission", explains the scientist. "What's more, we know that in the course of the next 150 years the cavities will fill with groundwater and that in the medium to long term the groundwater near the surface may also be contaminated." Although a suitability study was carried out when the repository was first planned, this was not compared adequately with information conflicting with the plans, which came to light during the building phase, before operations began. There was a lack of prudence. Thus 44,000 tonnes of hazardous wastes were deposited in Stocamine, including galvanisation waste from the metals industry, asbestos and pesticides. The issue of what to do with this after the closure of the repository was addressed by a steering committee (COPIL Stocamine), of which Stefan Alt was a member, between autumn 2010 and summer 2011. "The minimum consensus of this committee was the recommendation to retrieve the most toxic wastes and then attempt to refill and seal the underground cavities", says Stefan Alt. However, the Oeko-Institut expert favours full retrieval. "In the course of a salvage operation all the waste has to be sifted through in any case," he explains, "so retrieval of the total waste is only a question of cost." Only asbestos can be left in Stocamine, he thinks, explaining: "Asbestos does not pose a risk in the event of flooding, but it would be dangerous for workers involved in retrieval." In the scientist's

view a Plan B is needed as well, in case retrieval is unsuccessful. "In that case we would have to take steps to seal in the waste underground as best we could", says Alt, "which would of course also mean that the repository would have to be monitored for ever."

Another example that shows the consequences of imprudent use of underground space is the abandoned Asse II mine near Wolfenbüttel, which until the end of the 1970s was misused for disposing of radioactive waste under the guise of a research establishment. Water has long been seeping into the former salt mine, and it is unstable and at risk of flooding. On behalf of the German Federal Environment Ministry, the Oeko-Institut is using its expertise to monitor the process that has been set up to counter this danger. "All the waste should be retrieved", says Stefan Alt, "but as yet we don't know enough about the present situation in the storage chambers. That is why we can't yet assess well enough how retrieval can be organised safely and whether it is justified in terms of the risks for the workers underground". It could happen that the situation in Asse gets out of control and the mine has to be abandoned, and it is entirely possible that the retrieval could fail. "We need an emergency plan", says the Oeko-Institut expert, "which is why preparations must be made in parallel for refilling." The Asse mine would then be classified as a contaminated site: posing high risk and requiring permanent monitoring.

In a statement on the issue of using worked-out open cuts as repositories for lignite ash and slag, Stefan Alt has set out the kind of prudence that is needed for the continued use of depleted opencast mining sites. "Firstly I compiled on behalf of the Stommeln residents group a list of the types and quantities of waste arising from converting lignite into electricity, as well as the total content of pollutants and their readily leachable proportions", he explains. "This lignite ash contains lead, chromium and arsenic, amongst other things." Alt also characterised the requirements upon storage. "Heavy metals and arsenic can leach out if the waste comes into contact with water, which of course presents particular safety requirements for the way it is stored." He adds that the Oeko-Institut pointed this out as long ago as the 1980s. The current regulations require a geological barrier at the base to protect the groundwater and a cap on the repository to guard against leachate forming. Whether older repositories comply with this remains to be investigated, says Alt. "Since inorganic pollutants such as heavy metals and arsenic don't degrade, whereas technical barriers have a limited lifespan, the groundwater at the sites of repositories like these must be monitored in perpetuity", the scientist insists. "And, as well as that, we need to prepare action plans for the possibility of groundwater penetration and contamination."

Care in the repository

The examples make it clear: prudence underground is essential. Mistakes with underground disposal can have serious impacts. They produce the contaminated sites of the future and create the need for long-term monitoring and complex clean-up operations. "Nobody should proceed without due care when using underground spaces", says Stefan Alt, "not least because we'll continue to need them very much in future". And that's not just when we travel by tube or want to park the car.

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